



MAKING AN IMPACT ON U.S. MANUFACTURING

**NIST**  
National Institute of  
Standards and Technology  
U.S. Department of Commerce

# Collaborative Robotics Workshop 2015

## Advantages and Challenges for Small Manufacturers



*Charles I. Ecker Business Training Center*

*Columbia, MD*

*October 7, 2015*



Georgia  
Tech



Ohio

John R. Kasich, Governor

Development  
Services Agency

Christiane Schmenk, Director



TechSolve



MEP • MANUFACTURING  
EXTENSION PARTNERSHIP

[www.nist.gov/mep](http://www.nist.gov/mep)

[mfg@nist.gov](mailto:mfg@nist.gov)

(301) 975-5020

# Agenda

8:00 am	Registration and Continental Breakfast	
8:30 am	Welcome Remarks and Workshop Introduction	
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4:30 pm	ADJOURN	





# Welcome and NIST Introduction

Al Wavering, Chief  
Intelligent Systems Division  
Engineering Laboratory  
National Institute of Standards and Technology  
U.S. Department of Commerce

October 2015





# NIST's Mission – Working with Industry to Accelerate Innovation

- To promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life



©R. Rathe



# NIST Programs



©Robert Rathe

## NIST Laboratories

- Provide measurement solutions, advance standards that drive innovation and reduce risks of technology adoption



Marten Czamanske/shutterstock

## Hollings Manufacturing Extension Partnership

- Helps smaller manufacturers compete globally



Sharp

## Baldrige Performance Excellence Program

- Promotes and recognizes performance excellence



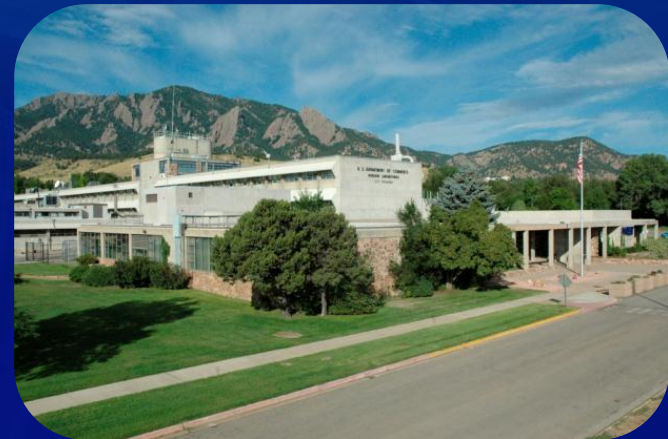
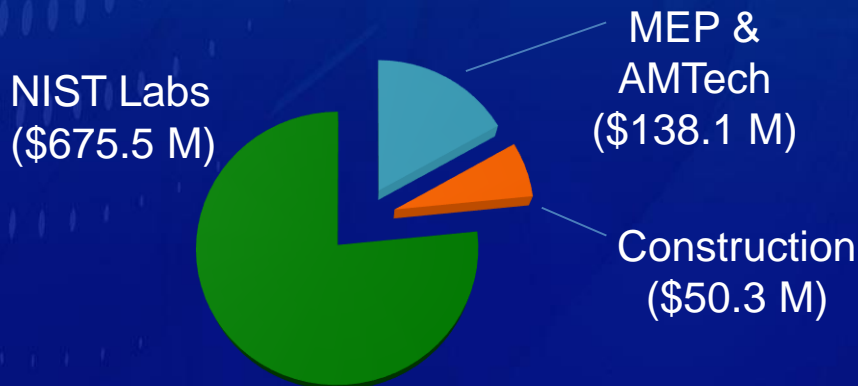


# NIST: Basic Stats and Facts

- Major assets
    - ~ 3,000 employees
    - ~ 2,700 associates and facilities users
    - ~ 1,200 field staff in partner organizations
- Two main locations:  
Gaithersburg, MD  
Boulder, CO



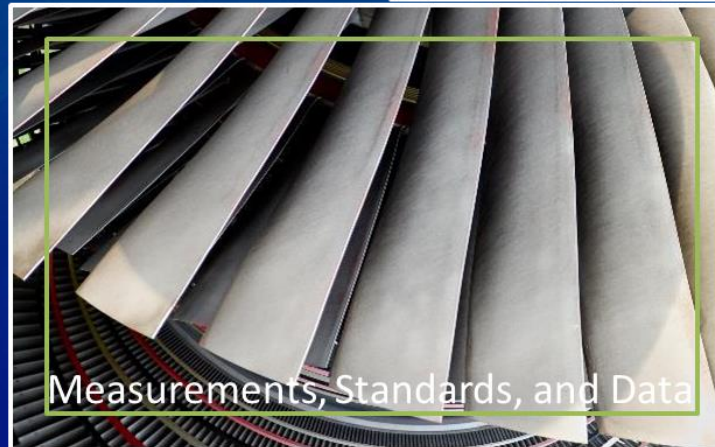
## FY 2015 Appropriations \$863.9 M



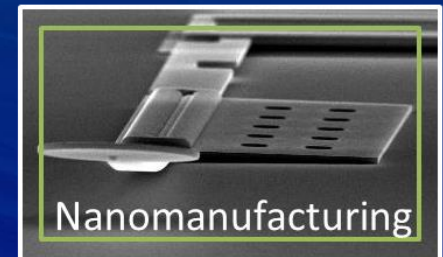
# NIST Labs Priority Research Area: Advanced Manufacturing



Dmitry\_Kalinovsky/shutterstock



Yurchyts/shutterstock



US Naval Academy

## The NIST Engineering Lab contribution:

Measurement science and standards to **drive innovation** and **reduce risks of adoption** of Smart Manufacturing technologies



Beattie Young/NIST





# Engineering Laboratory Smart Manufacturing Programs

Measurement science and standards to **enable system-level technologies**

- Smart Manufacturing Systems Design and Analysis
- Smart Manufacturing Operations Planning and Control

Measurement science and standards to **enable disruptive process technologies**

- **Robotic Systems for Smart Manufacturing**
- Measurement Science for Additive Manufacturing

Learn more at [www.nist.gov/el/goalsprograms.cfm](http://www.nist.gov/el/goalsprograms.cfm)

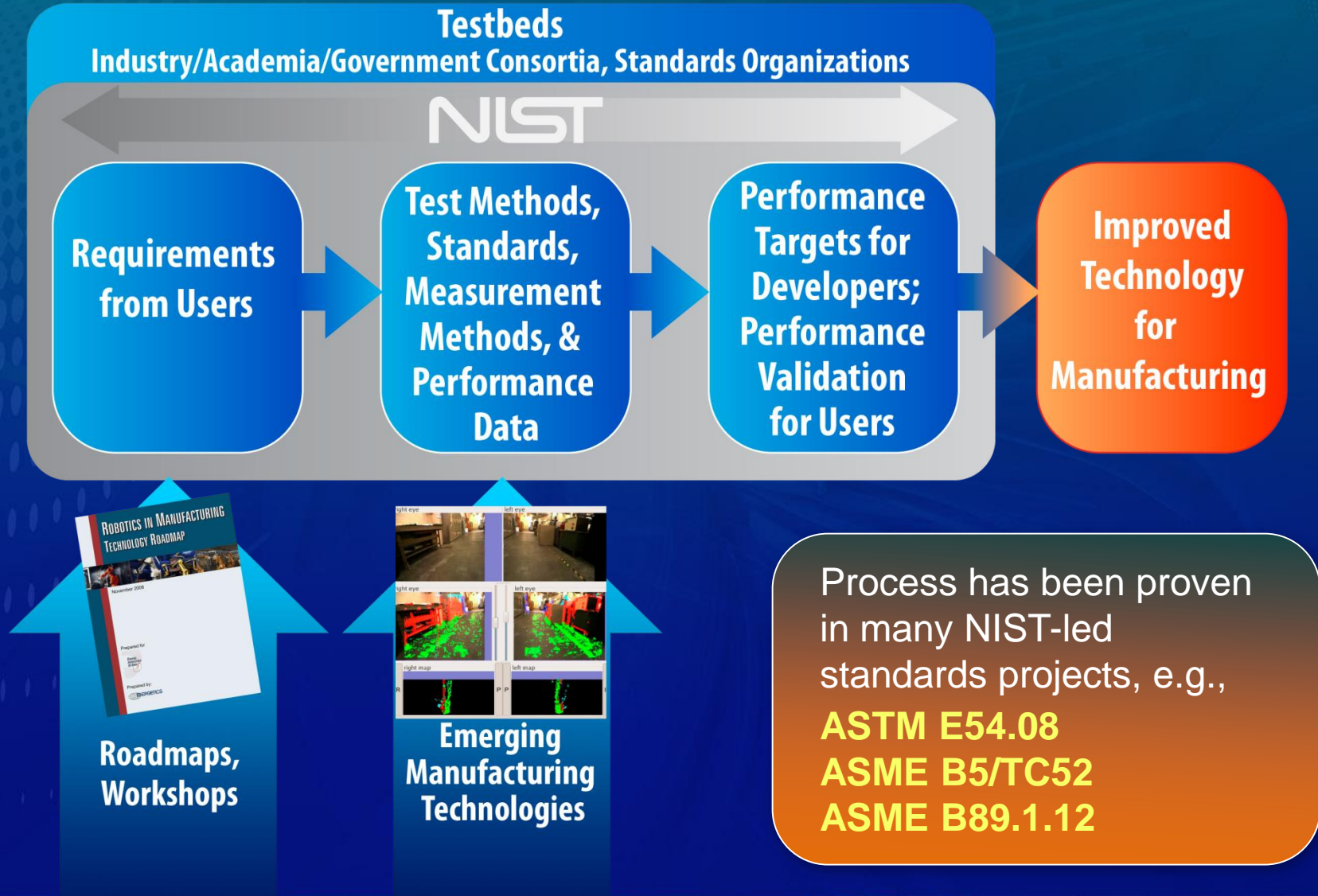


# Questions to be answered for new technologies

- What can available technologies do?
- What would users like future technologies to be able to do?
- What test methods can technology developers and users apply to establish a shared understanding of capabilities and performance?
- What standards can help users integrate new technologies more easily?
- What guidelines would help users make most effective use of available technologies?



# Driving Innovation and Reducing Risks of Technology Adoption Through Measurements and Standards





# Contact Information

Albert J. Wavering  
Chief, Intelligent  
Systems Division

301 975 3418  
albert.wavering@nist.gov

NIST Engineering Laboratory  
100 Bureau Drive Stop 8200  
Gaithersburg, MD 20899-8200

[www.nist.gov/el/isd](http://www.nist.gov/el/isd)





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4:30 pm	ADJOURN	





# Robotics for Manufacturing Applications

## Current State of Collaborative Robotics and Flexible Automation

Jeremy Marvel, Ph.D.  
National Institute of Standards and Technology  
Engineering Laboratory, Intelligent Systems Division

7 October, 2015

# Why is NIST involved?

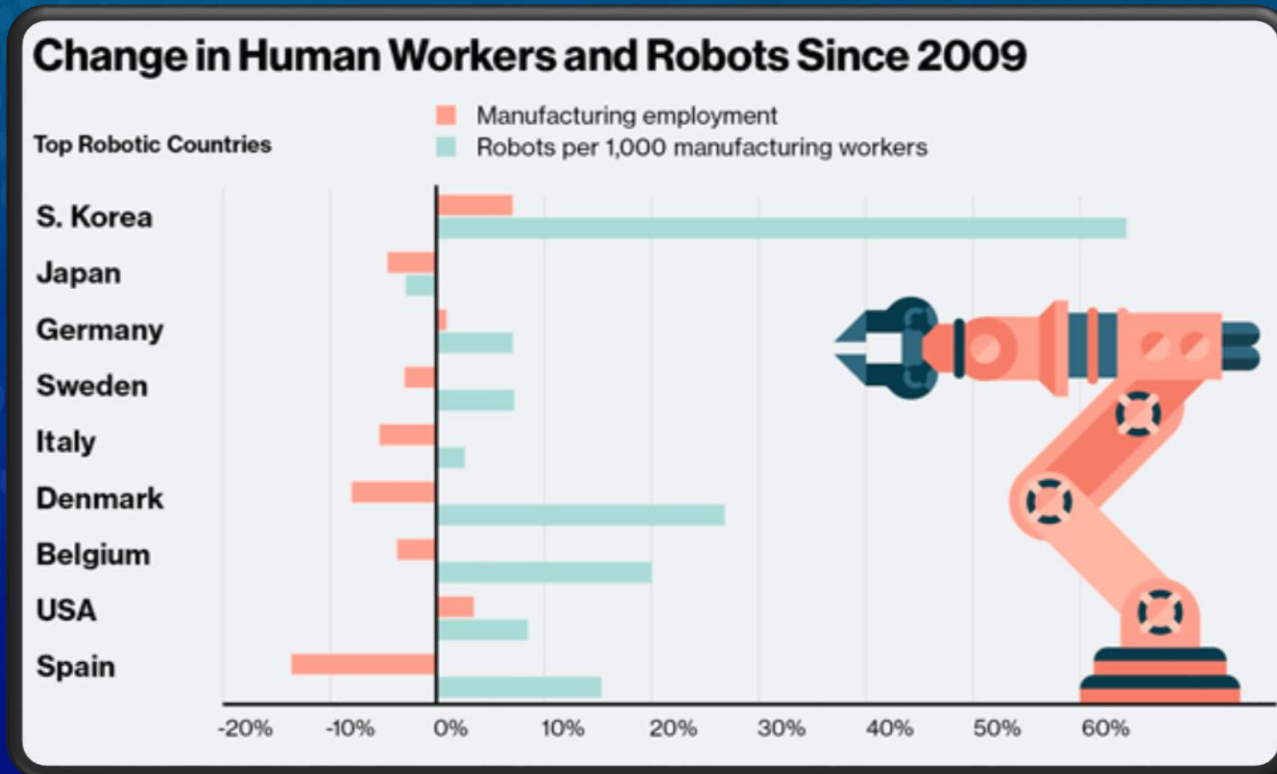
- “The United States is losing leadership in manufacturing—not just in low-tech industries and products and not just due to low-wages abroad.”<sup>1</sup>
- Advanced robotics “could provide broad based innovation benefiting multiple industries...”<sup>1</sup>
- The deployment of robots is hindered by a lack of measurement science for quantitatively specifying the required performance in key areas, as well as objectively measuring how well robots meet the requirements.<sup>2</sup>

<sup>1</sup> PCAST, “Report to the President on Ensuring American Leadership in Advanced Manufacturing”, June, 2011

<sup>2</sup> Robotics in Manufacturing Technology Roadmap," Sponsored by U.S. Department of Energy, October 2006.



# The Robotics Landscape



Source: "Robots Rising," MIT Technology Review  
<http://www.technologyreview.com/graphiti/529971/robots-rising/>





# Robotics in Manufacturing

10% of potential users benefit from robotics

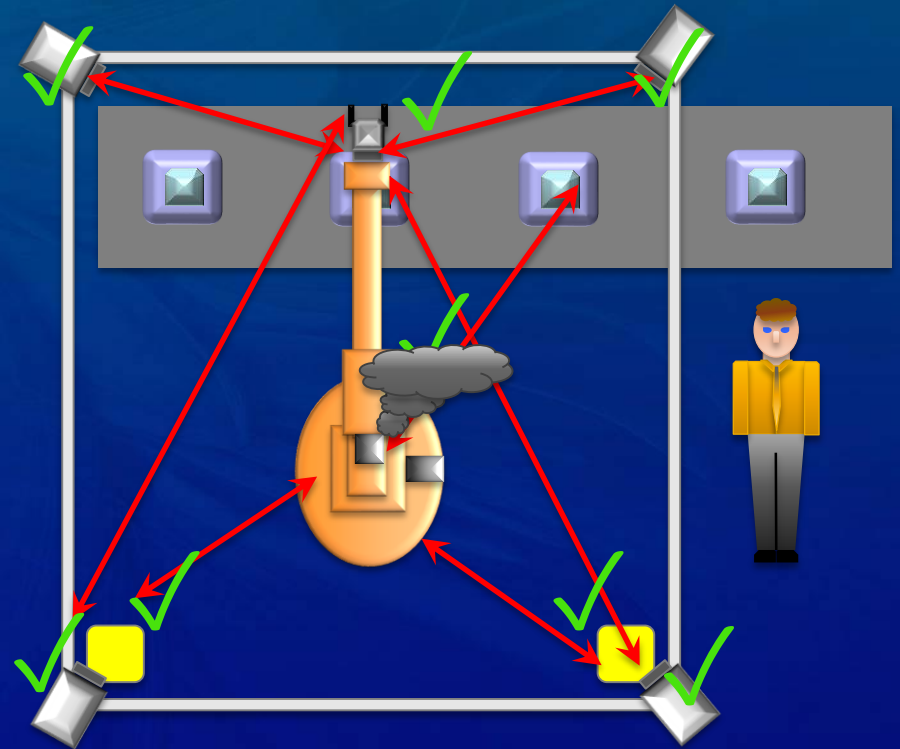
- Cost
- Safety
- Ease of integration/use
- Impact on productivity
- Real estate limitations



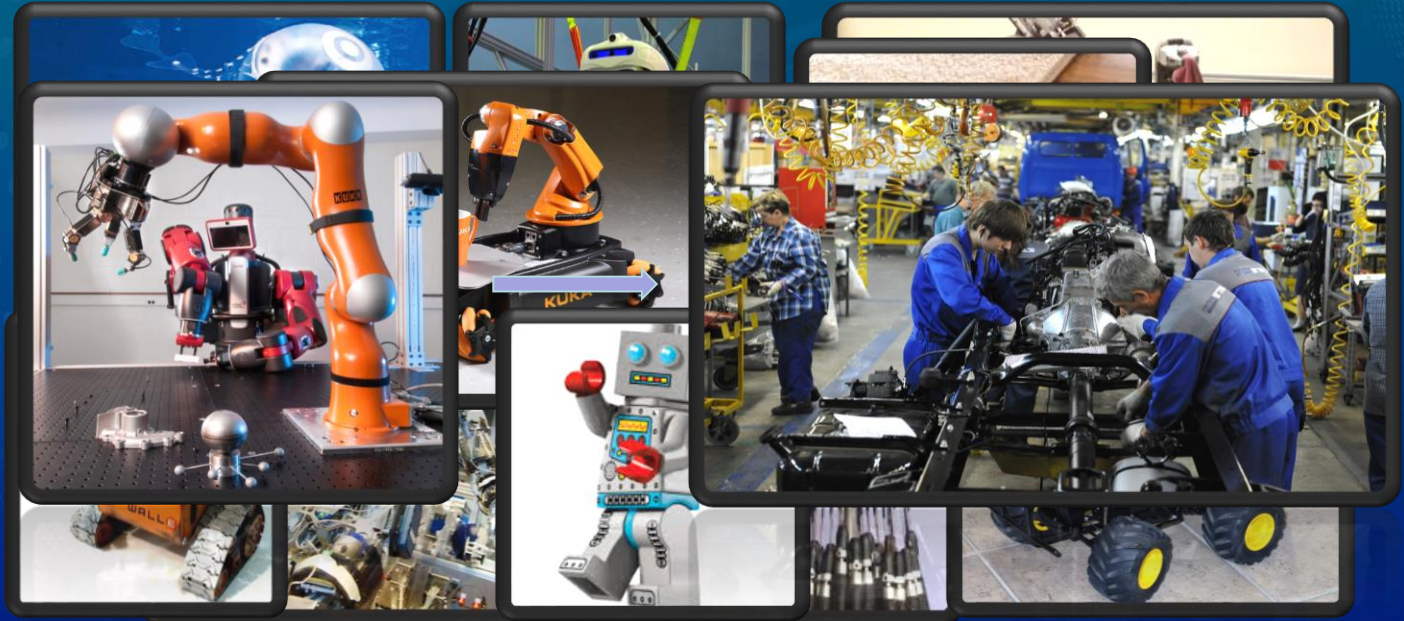
# The Cost of Robotics

Process  
Robot  
Safeguards  
Sensing  
Tooling

Integration  
Training  
Validation  
Maintenance



- Robots
- Safeguards
- Sensing
- Tooling
- Integration
- Training
- Validation
- Maintenance



- Manufacturing environments are not laboratories
- Relatively few end-users are willing to take the gamble on unverified tech
- Non-robust solutions may have negative value added



# State of the Art

## Robots

Safeguards  
Sensing  
Tooling  
Integration  
Training  
Validation  
Maintenance





# State of the Art

Robots

**Safeguards**

Sensing

Tooling

Integration

Training

Validation

Maintenance



# State of the Art

Robots

Safeguards

**Sensing**

Tooling

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Training

Validation

Maintenance



# State of the Art

Robots

Safeguards

Sensing

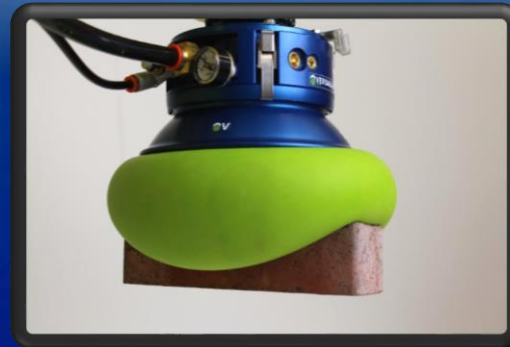
**Tooling**

Integration

Training

Validation

Maintenance





# State of the Art

Robots

Safeguards

Sensing

Tooling

**Integration**

Training

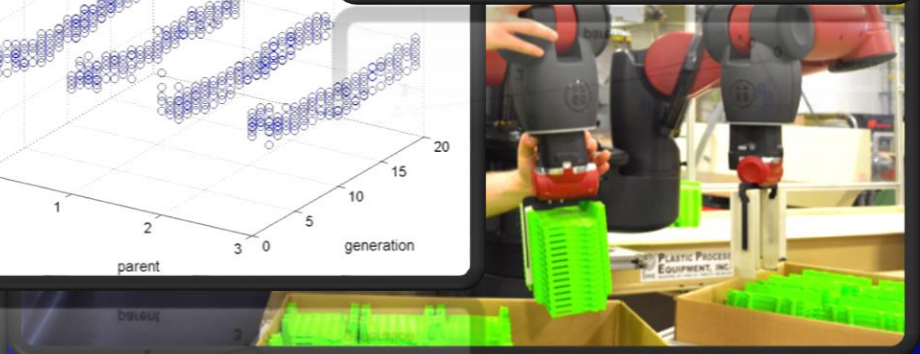
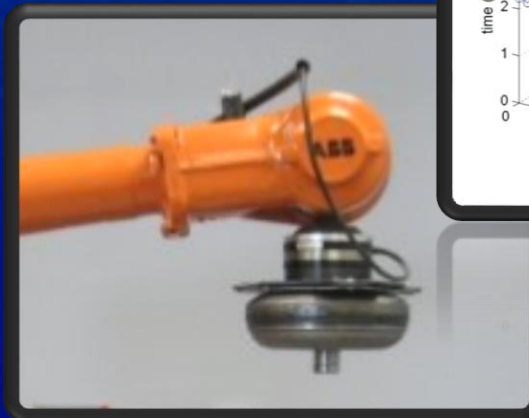
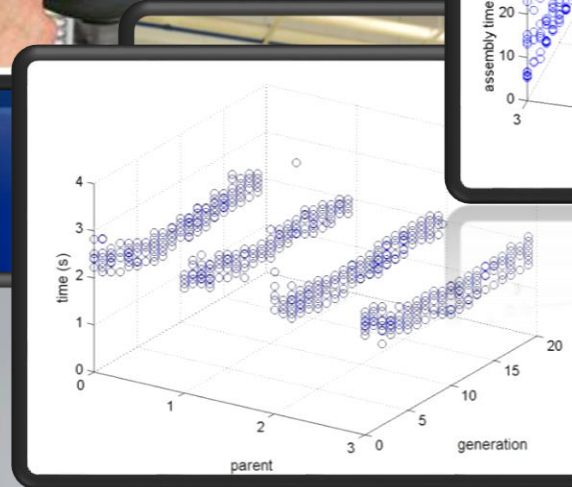
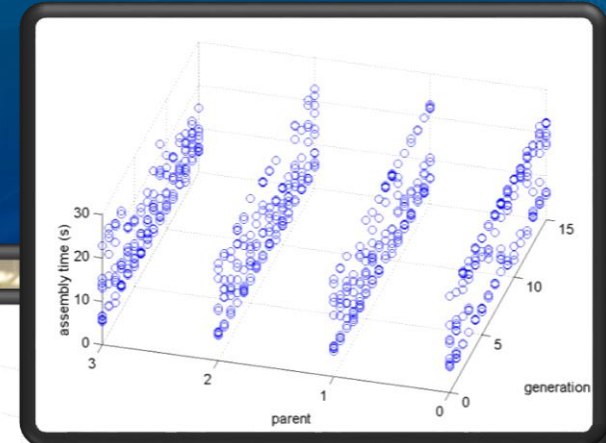
Validation

Maintenance

The MTConnect logo features the letters 'MT' in a stylized blue font with horizontal lines, followed by the word 'Connect' in a bold black font.The ROS industrial logo shows a blue line-art robotic arm on the left, followed by the text 'ROS' in a large blue font and 'industrial' in a smaller blue font below it.This block contains two logos. The top one is 'EtherNet/IP' with a yellow sun-like icon above the text. The bottom one is 'DeviceNet' with a similar yellow icon above the text.The Modbus logo features a cluster of yellow circles with green arrows pointing outwards from a central point, followed by the word 'Modbus' in a large blue font.The EtherCAT Technology Group logo includes the text 'EtherCAT' in a large black font, with a red arrow pointing right above the 'T'. Below it, 'Technology Group' is written in a smaller black font.

# State of the Art

Robots  
Safeguards  
Sensing  
Tooling  
Integration  
**Training**  
Validation  
Maintenance



# State of the Art

Robots

Safeguards

Sensing

Tooling

Integration

Training

**Validation**

Maintenance

INTERNATIONAL  
STANDARD

ISO  
9283

$$RP_J(\mathbf{j}_{r,\tau}) = \begin{bmatrix} RP_J(j1_{r,\tau}) \\ \vdots \\ RP_J(jM_{r,\tau}) \end{bmatrix} = \begin{bmatrix} \left( \frac{1}{N} \sum_{j=1}^N A_J(j1_{j,r,\tau}) \right) + 3\sigma_{J1} \\ \vdots \\ \left( \frac{1}{N} \sum_{j=1}^N A_J(jM_{j,r,\tau}) \right) + 3\sigma_{JM} \end{bmatrix}$$

*Robots manipulateurs industriels — Critères de performance et méthodes*

$$\mathbf{F}_{r,\tau} = F_r(T(\tau)) = \sum_{i=1}^K (\mathbf{f}_i \mathbf{n}_i - \mathbf{p}_{r,t} \mathbf{v}_i),$$

$$\mathbf{M}_{r,\tau} = M_r(T(\tau)) = \sum_{i=1}^K \left( (\mathbf{g}_i \times \mathbf{f}_i \mathbf{n}_i) - (\mathbf{g}_i \times \mathbf{p}_{r,t} \mathbf{v}_i) \right)$$



Reference number  
ISO 9283:1996(E)



ISO 9283:1996(E)  
performance criteria





# State of the Art

Robots

Safeguards

Sensing

Tooling

Integration

Training

Validation

***Maintenance***



# A Brief Note About Safety



Source: The Day. 1985



# Thank You!

## Jeremy Marvel

Project Leader, Performance of Collaborative Robot Systems  
National Institute of Standards and Technology  
Engineering Laboratory, Intelligent Systems Division  
Gaithersburg, MD, USA

[jeremy.marvel@nist.gov](mailto:jeremy.marvel@nist.gov)  
1.301.975.4592

<http://www.nist.gov/el/isd/ms/pcrs.cfm>







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4:30 pm	ADJOURN	





# Collaborative Robots

Justin Griffin

Robotics Specialist

[jgriffin@onexia.com](mailto:jgriffin@onexia.com)

610.431.7271 x305

610-331-4151 (cell)





# Collaborative Robots Successes

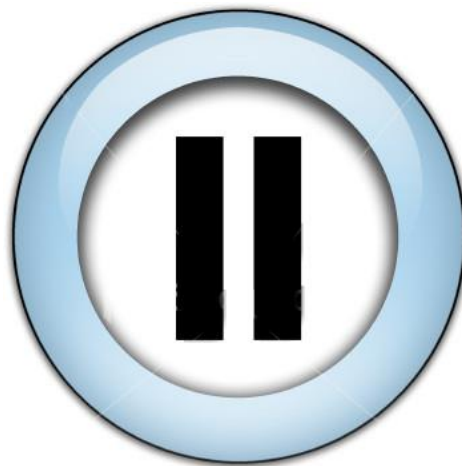


**Rapid Line Demonstrates Success  
with Baxter**



**Steelcase Demonstrates Success  
with Sawyer**





# BREAK



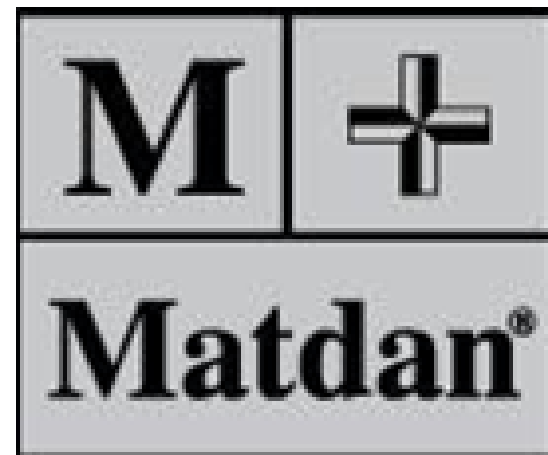


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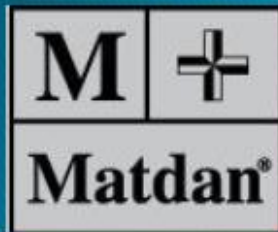
# Manufacturer Panel – Robotics Implementation



# Matdan<sup>®</sup>

## Collaborative Robotics Workshop

*Baltimore, Maryland  
October 7th, 2015*





# About Us

- ▶ Matdan Corporation was founded in 1992 with the mission  
To be a **customer driven, innovative**, globally recognized and respected fastener and hardware **solution provider**.
- ▶ Matdan originated in the electronics business and still today leverages short lead times into all its products.
- ▶ Key manufacturing competencies are turning, cold forming, stamping, injection molding, and die casting then assembled.



# Matdan Advantages

- ▶ Worldwide manufacturing and customer support
- ▶ Quick delivery of samples and prototypes
- ▶ Ability to hold blanket order inventory
- ▶ Custom Capability (over 50% custom products)
- ▶ Program Pricing
- ▶ Over 20 years experience supplying specialty hardware
- ▶ Rapid responses
- ▶ ISO9001:2008/AS9100:2009 Aerospace Certified
- ▶ Low Cost–High Quality Alternative Supplier



# Markets Served

- ▶ Electronic Enclosures
- ▶ Digital Signage
- ▶ Networking
- ▶ Marine
- ▶ Automotive
- ▶ Military
- ▶ Aerospace/Aviation
- ▶ Sheet Metal Fabricators
- ▶ General Industrial Applications
  - HVAC, etc.





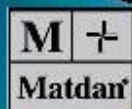
# Captive and Quick Access Fasteners



# Draw and Compression Latches



# Matdan Global Presence



20+ Years Supplying Specialty Hardware and Tooling





# Quality Certifications

## Matdan Corporation

### ISO9001/AS9100C



## Matdan Specialty Hardware

### ISO9001



## Matdan Aerospace Corporation

### GE S-523



# Current Automation

- ▶ **Controls**
  - PLC's, Arduino's, and Computer Interfaces
- ▶ **Inspection Technology**
  - Camera Systems, Laser Systems, Position Sensors
- ▶ **Vibratory Feed Bowls**
  - Coupled with Proximity Sensors and Rails
- ▶ **Mechanics**
  - Pneumatics and Cam Driven Machines



# Lessons Learned

- ▶ Every time a machine handles/picks up a part, is an opportunity for a free inspection.
- ▶ Audit machine inspections to locate systematic errors
- ▶ Anticipate and build in as much flexibility as possible upfront in your system
- ▶ There will be system bugs and trouble shooting
- ▶ Document as much as you can with drawings, trouble shooting guides and maintenance manuals to minimize machine “tribal knowledge”
- ▶ Build a system using technology you can technically get familiar and comfortable with



# Robotics Challenges

- ▶ Adaptive Systems
  - 10's of thousands of part combinations
  - How to present the part
- ▶ Quick Changeovers and Setups
  - Currently Extremely Short Changeovers
- ▶ Investment Costs
  - Equipment + Implementation + Maintenance
- ▶ Technical Barriers
  - Low Skill Workers ⇒ Highly Technical Workers
- ▶ Locating Robotics Supplier/Partner
- ▶ Ability to Repurpose Robots





# Contact Information

**Matt Arand**

**Engineering Manager**

**513-794-0500**

**[marand@matdanfasteners.com](mailto:marand@matdanfasteners.com)**

**10855 Millington Ct.**

**Cincinnati, Ohio 45242**

**[www.matdanfasteners.com](http://www.matdanfasteners.com)**

**[www.matdanaerospace.com](http://www.matdanaerospace.com)**



# TENAX<sup>®</sup>

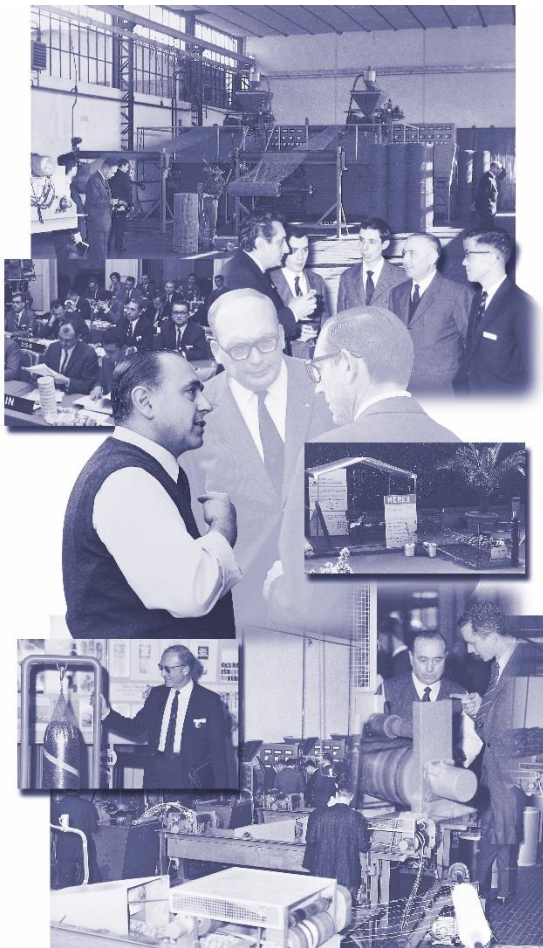
Tenax Automation

## Tenax Corporation

Originally established in 1960 in Italy, Tenax opened a distribution center in Ohio in 1983. In 1987 the company expanded its operation and moved to our current location in East Baltimore.

Tenax gained world-wide fame with its first US-produced product—orange safety fence for building and construction sites—which quickly spawned imitators all over the world. Currently Tenax Corporation serves the USA, Canada, Mexico, and Central and South America with specialty products for netting and fencing, pipe protection, construction, agricultural, gardening and DIY applications.

Throughout the years of growth and expansion, Tenax Corporation has maintained our promise to be a pioneer in the **Made in USA** movement. Tenax uses only prime selected raw material and domestic suppliers in support of our business.



## Our Values



Tenax is committed to building a lasting company that provides products and services of the highest quality.

We offer our employees a safe and rewarding work environment and strive to be a good corporate citizen in the communities in which we operate.

Tenax is focused on strategic growth through the responsible use and management of our resources.



# TENAX<sup>®</sup>

SOLUTIONS ALL AROUND YOU

## Winning Points

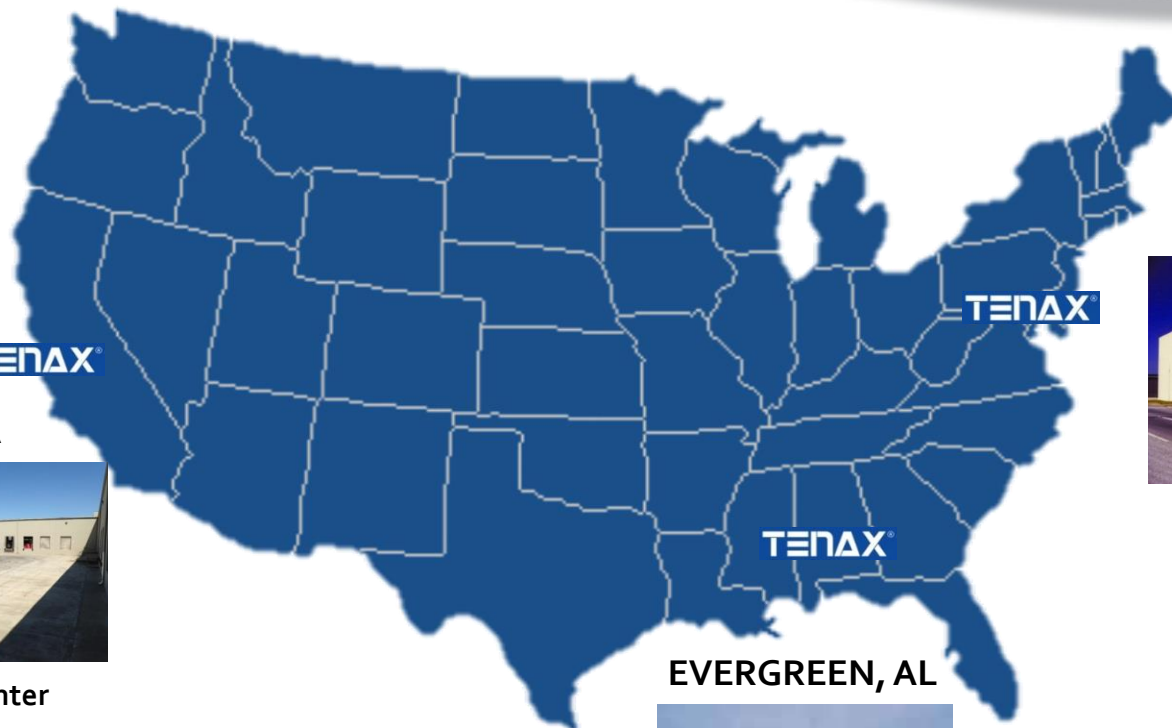


- Over 50 years of experience in the industry across the globe
- The Tenax name stands for quality that customers continue to look for and trust
- Tenax products are resistant to degradation, are UV stabilized, lightweight and easy to install
- Tenax products show innovation, versatility and are constantly improved
- Advanced logistics and stock availability year round
- Exclusive manufacturing processes

# TENAX<sup>®</sup>

SOLUTIONS ALL AROUND YOU

## Tenax Facilities



TENAX<sup>®</sup>

CERES, CA



Distribution Center

TENAX<sup>®</sup>

BALTIMORE, MD



Corporate Office &  
Manufacturing Plant

TENAX<sup>®</sup>

EVERGREEN, AL



Manufacturing Plant

# TENAX<sup>®</sup>

SOLUTIONS ALL AROUND YOU

## Divisions

DIY Pet & Garden

Construction

IND / AG

GEO

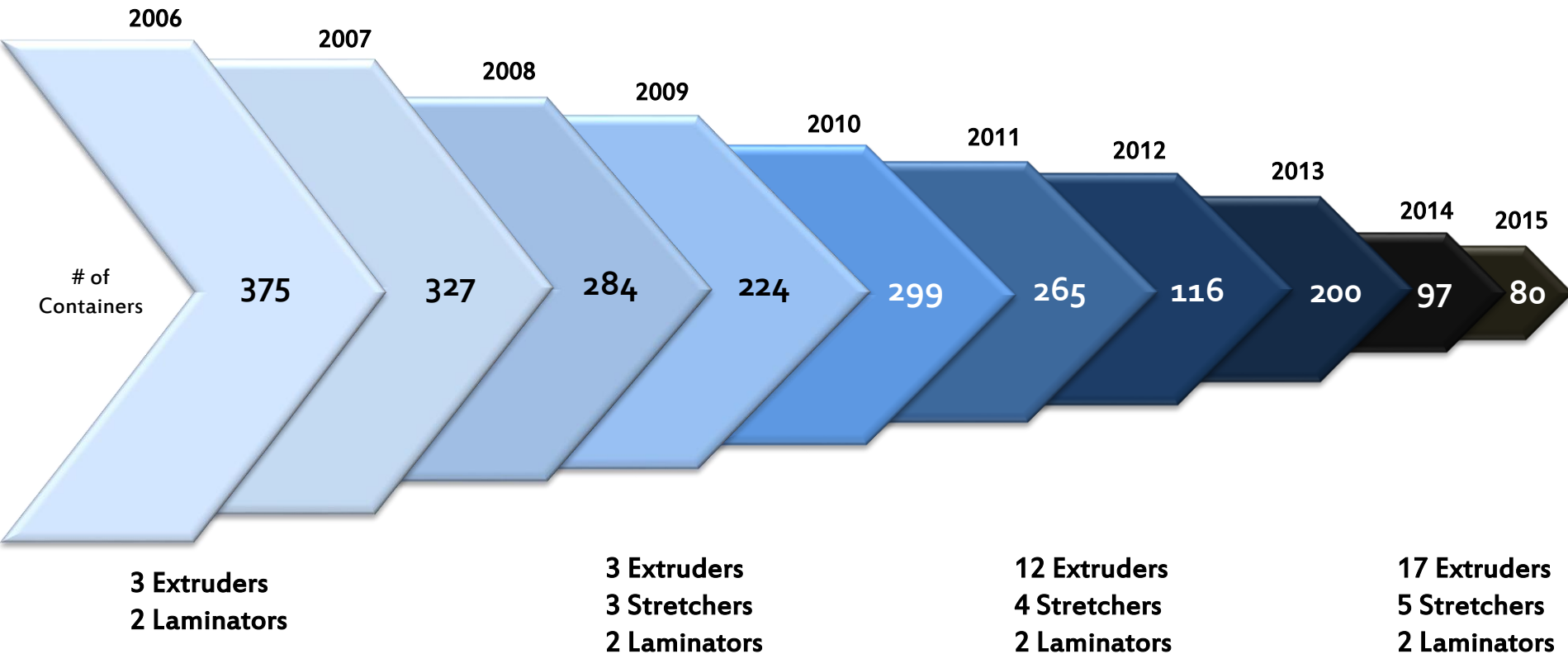




# TENAX<sup>®</sup>

SOLUTIONS ALL AROUND YOU

## Company Evolution

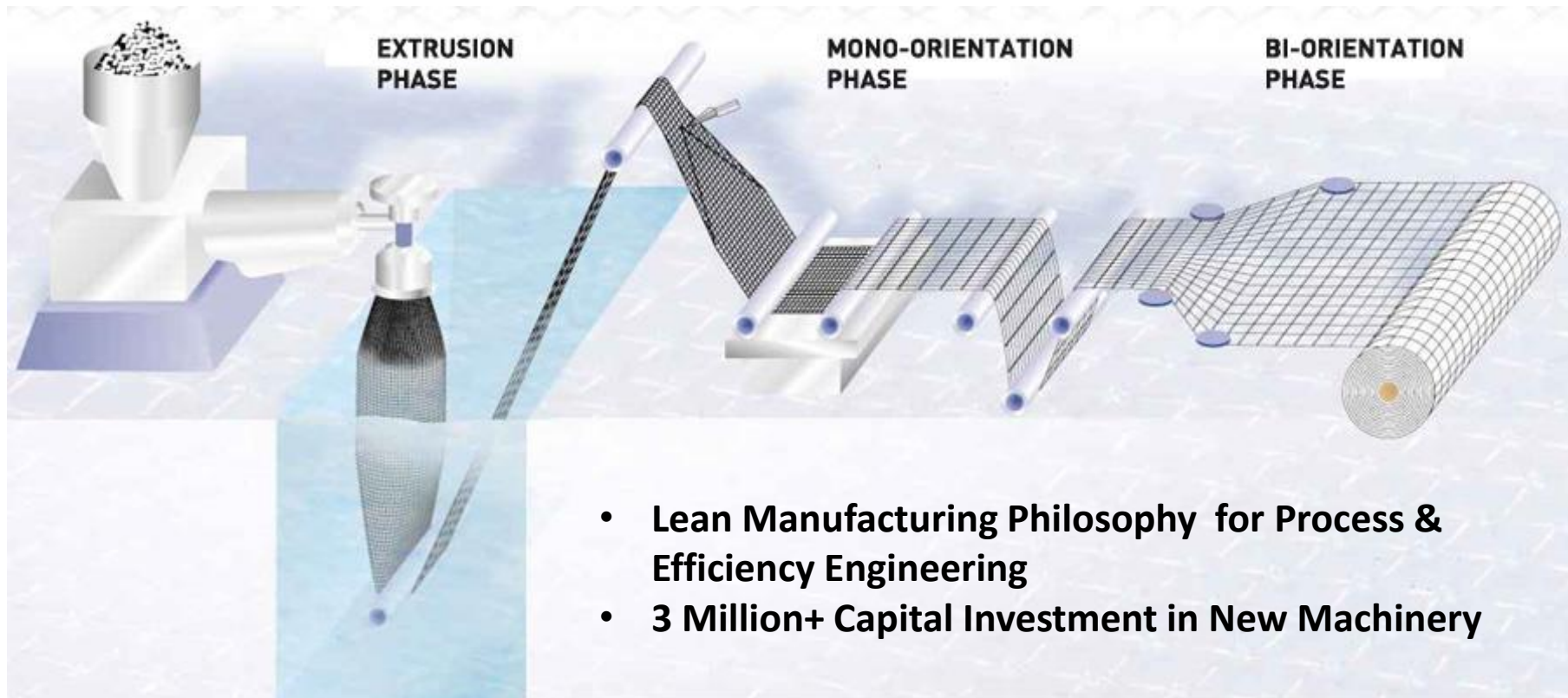




# TENAX<sup>®</sup>

SOLUTIONS ALL AROUND YOU

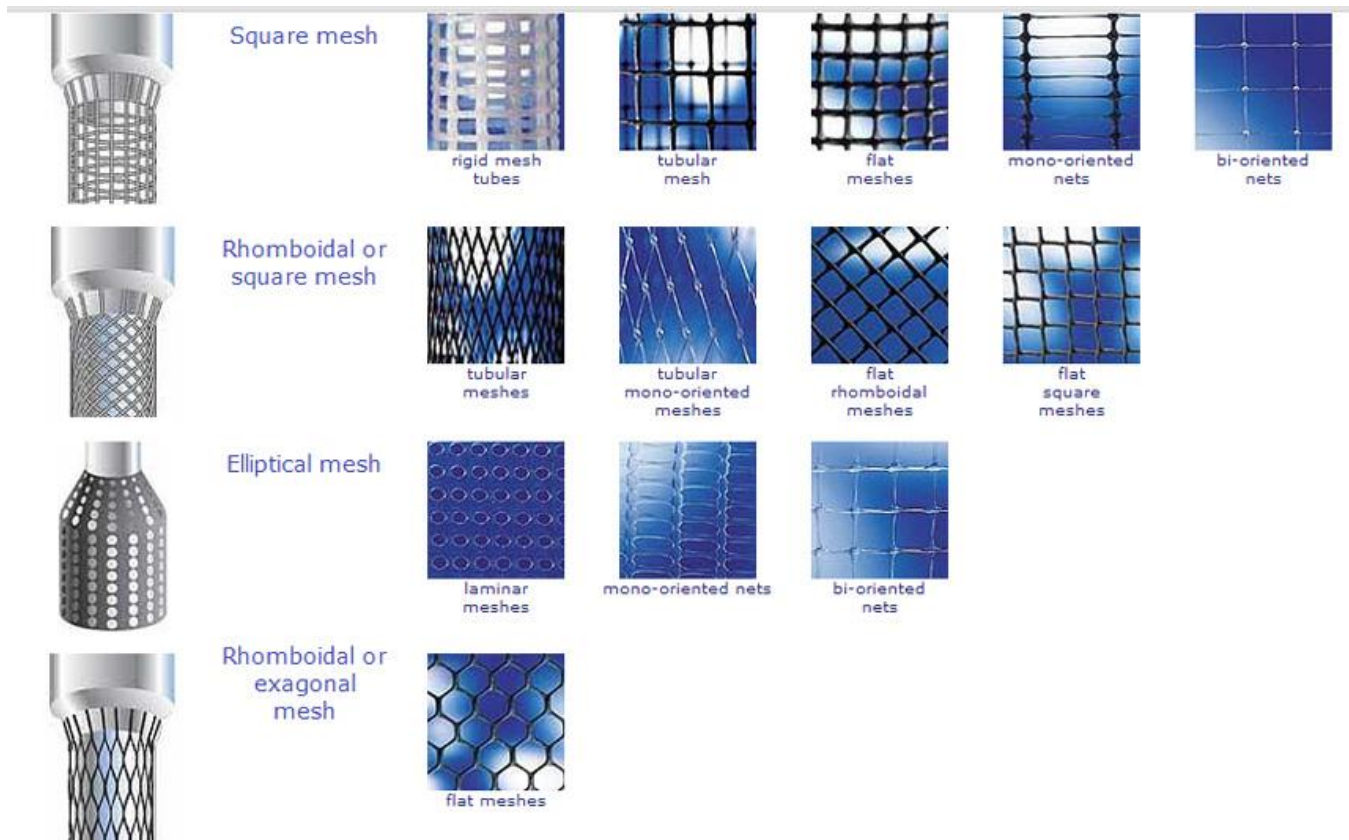
## Tenax Technology



# TENAX<sup>®</sup>

SOLUTIONS ALL AROUND YOU

## Tenax Technology





## Evolving With Automation



## Investing in Baltimore

**\$4.5M** INVESTED  
IN THE LAST 2 YEARS

**45K** SQ  
FT  
FACILITY EXPANSION

Increase efficiency and reduce costs



**5 MACHINES ADDED**  
4 EXTRUDERS | 1 RAM STRETCHER



Now able to produce products that had  
only been manufactured in Europe.



Production  
Engineer

**20% CAPACITY  
INCREASE**  
FOR THE CONSUMER MARKET PRODUCTS



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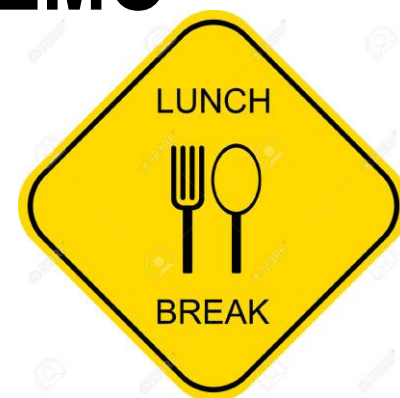


# FACILITATED PANEL



# LUNCH AND ROBOTICS DEMO

- Lunch Buffet is provided in the back of the room
- **We plan to reconvene promptly at 12:45pm**



**ONExia Inc**  
*Excellence in Automation*

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# Robot Systems Adoption in Manufacturing

## Overview of Typical Challenges and Barriers

# What are the Principal Barriers to Deploying Robots?



# Why is it not Cost-Effective?

- *Ad hoc*, expensive custom solutions for
  - installation
  - integration with rest of equipment, systems
  - fixturing
  - tooling
- Estimates of added costs of between 3-9 times the price of a robot





# Why is it not Cost-Effective?

- Lengthy programming is required for each new part
- Tweaking and tuning of positions, coordination
- For small batches, short runs, it's not worth it





# Why is it not Cost-Effective?

- Robot has limited or no ability to detect
  - failures
  - variations in part location, size/shape
- Robot has limited or no ability to correct for failures



# Why is it not Cost-Effective?

- Due to safety concerns, robots are typically separated from humans
- Fencing or other barriers are expensive and require a lot of floor space
- Robots cannot collaborate with humans or assist them



# Why is it not Cost-Effective?

- **Specialized knowledge may be required for**
  - **installation**
  - **programming**
  - **maintenance (including debugging problems)**

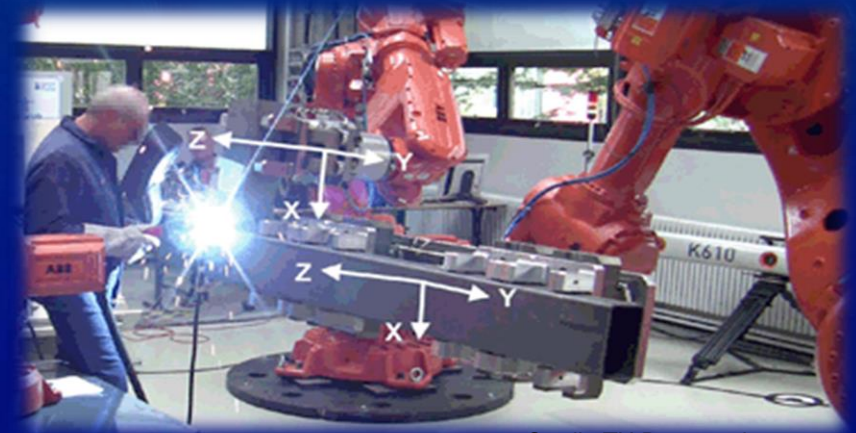


Current State:  
10% of potential users  
benefit from robots



Credit: Robotunits

Future Vision:  
Greater customer/market  
responsiveness,  
productivity & higher  
quality that is achievable  
by small, medium, and  
large enterprises



Credit: TU Dortmund





# TABLE TOP DISCUSSIONS



# Topics for Discussion

**What benefits would you expect to gain from adopting robots?**

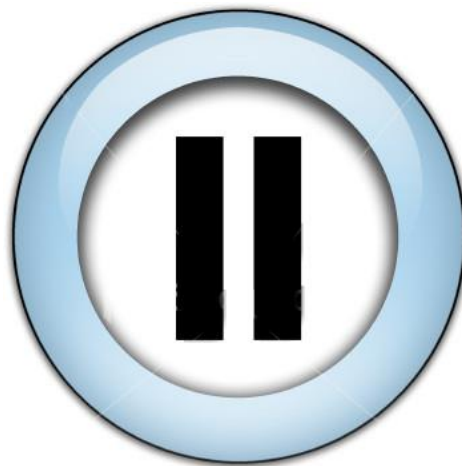
**What would be some tasks you would like to have robots perform in your enterprise?**

**What would help you learn more about whether your facility could benefit from robots? What information would you like to know about robots?**

**What has kept you from using robots thus far?**

**What types of robots would you envision using in your facilities?**





# BREAK



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4:00 pm	Q&A, Wrap Up and Discussion of Next Steps	
4:30 pm	ADJOURN	





# Table Top Report Outs



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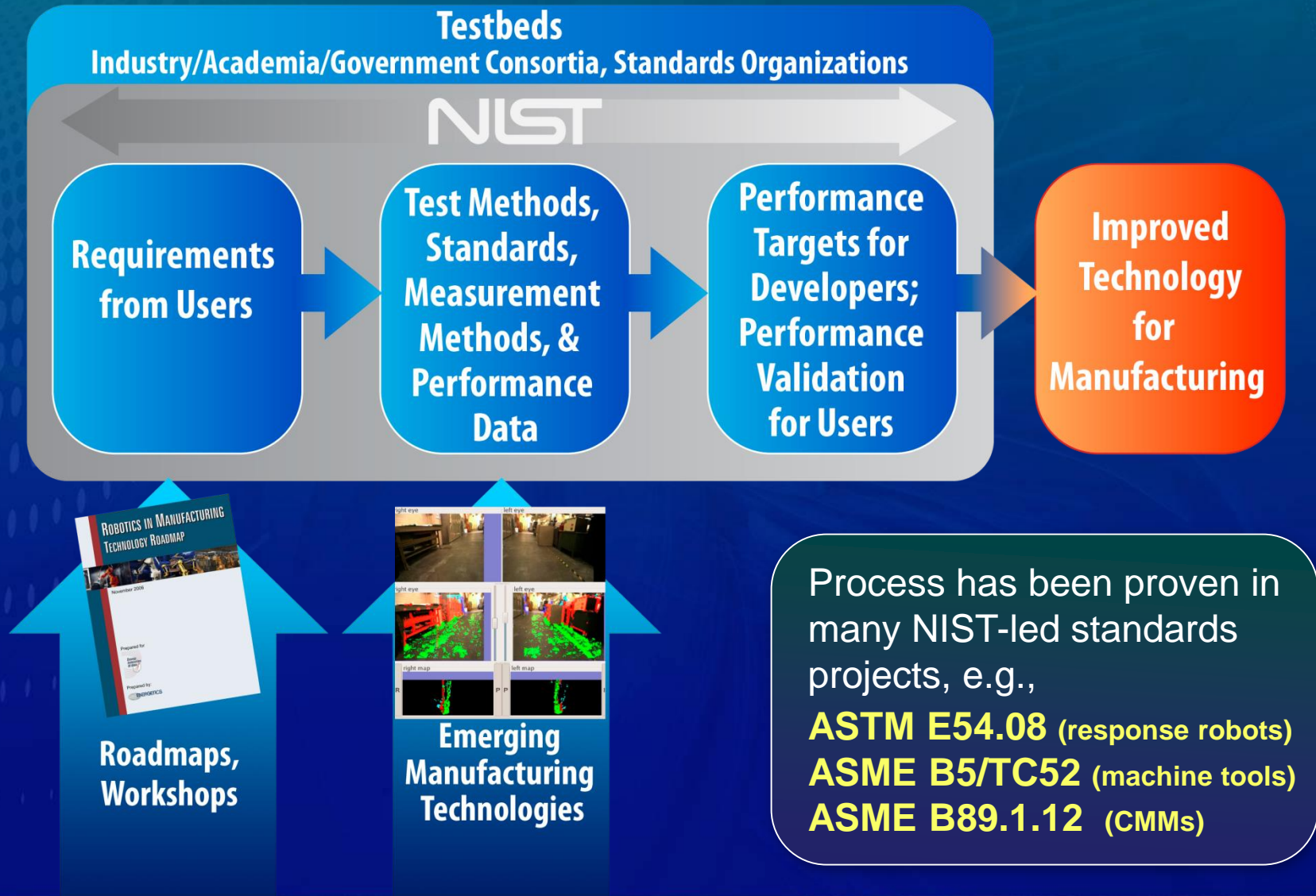
# Working with the NIST Engineering Lab to Advance Robotic Systems

Elena Messina

Leader, Manipulation & Mobility Systems Group  
Manager, Robotic Systems for Smart Manufacturing Systems Program  
Intelligent Systems Division  
National Institute of Standards and Technology

301-975-3510  
[elena.messina@nist.gov](mailto:elena.messina@nist.gov)

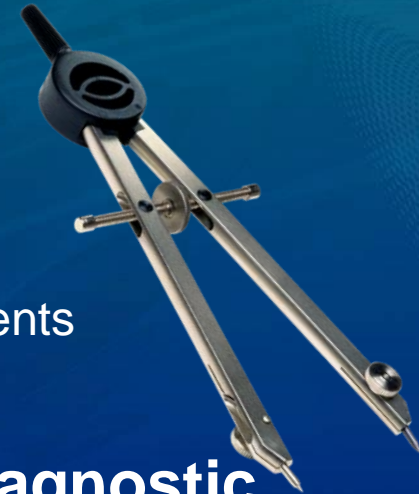
# Driving Innovation and Reducing Risks of Technology Adoption Through Measurements and Standards





# Robotic Systems for Smart Manufacturing

- **Industry-driven performance requirements**
  - Balance user's needs with technology state of the art
- **Measure along a spectrum of performance**
  - Not pass/fail testing for performance evaluation
  - Characterize performance to match solutions to deployments
  - Reduce risk of adoption of new technologies
- **Test methods and metrics that are design-agnostic**
  - Evaluate performance in the task/functional space, leaving the design space open for creative solutions
- **Test methods stimulate innovation towards solving industry's needs**
  - Strive for easily disseminated and reproduced artifacts and protocols
  - Provide common language for expressing requirements and capabilities
- **Testbeds, pilot projects for proving out new approaches; convening all stakeholders**



# Opportunities

- Provide input on key performance areas, gaps
  - NIST can be conduit to standards bodies; researchers; robot developers
  - Participate directly (low cost; WebEx)
- Provide use cases that can be tried on testbeds



# Examples of Current Efforts@ NIST

## AGV (Mobile Robots)

- Performance Standards – ASTM F45
- Calibration tools (position/sensing)
- Mobile Manipulation safety standards – RIA
- Mobile Manipulation performance tests

## Vision & Part Handling

- Part location (static & dynamic) performance characterization – ASTM E57
- Robotic hand metrics and test methods



# Examples of Current Efforts@ NIST

## Collaborative Robots

- RIA/ISO safety standards (speed & separation monitoring; power and force limiting)
- New devices, interaction methods (human-robot)
- Measure robot-robot collaboration

## Integration with Enterprise/Other Equipment

- MTConnect for robots; MTConnect-ROS-Industrial bridge





# Examples of Current Efforts@ NIST

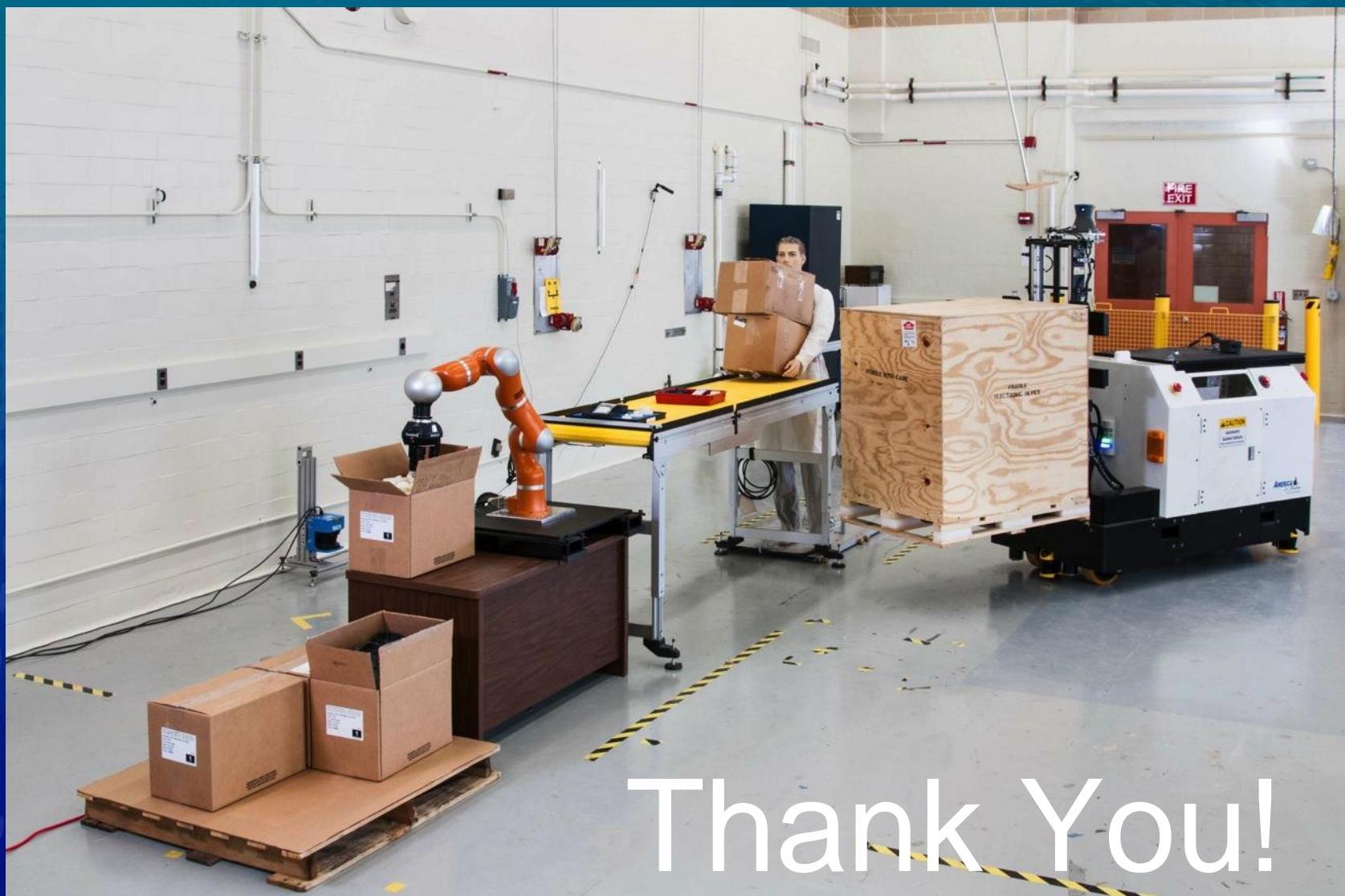
## Agility

- Tests & tools to improve ease of programming/tolerance to variations/detection of failures

## Current application areas of focus

- Kitting
- Assembly
  - pick and place is part of this





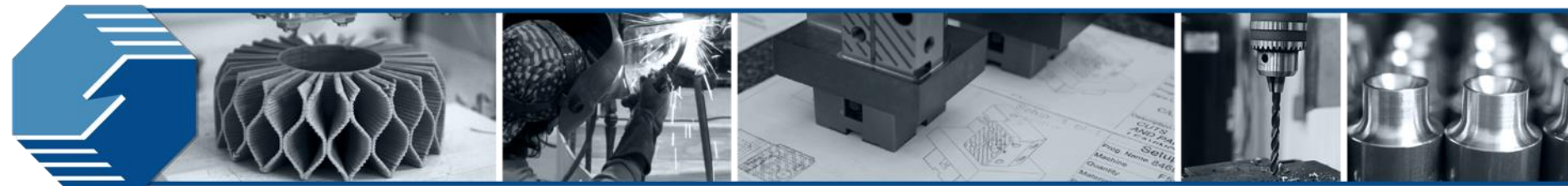
# Thank You!

<http://www.nist.gov/el/isd/ms/rssm.cfm>

elena.messina@nist.gov

engineering laboratory





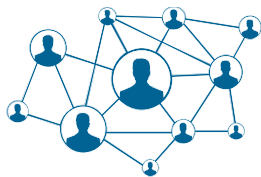
MAKING AN IMPACT ON U.S. MANUFACTURING

# Opportunities & Resources – Working with NIST and with MEP

*Collaborative Robotics Workshop 2015*  
*Advantages and Challenges for Small Manufacturers*  
**Charles I. Ecker Business Training Center**  
**Columbia, MD**  
**October 7, 2015**

David Stieren  
Technical Manager, Program Development  
NIST MEP  
[david.stieren@nist.gov](mailto:david.stieren@nist.gov) 301-975-3197  
[www.nist.gov/mep](http://www.nist.gov/mep)

# MEP Summary



## National Network

MEP Center in all 50 U.S. states plus Puerto Rico. System-wide non-Federal staff of over 1,200 individuals in >400 service locations assisting U.S. manufacturers. Contracting with >2,500 3<sup>rd</sup> party service providers



## Partnership Model

Federal, State and Industry



## MEP Budget & Business Model

\$130M FY15 Federal Budget  
*with Cost Share Requirements for Centers*



## Local → National Connection

System of Centers providing localized service to manufacturers in each State – with National reach and resources



## MEP Strategy: Global Competitiveness and Growth

Mission to provide direct, hands-on tech & business assistance to domestic manufacturers to help them compete and grow



## Technology Acceleration

MEP connects U.S. mfrs. with technology opportunities and solutions they require to grow and compete in the global marketplace





# MEP National Network

[www.nist.gov/mep](http://www.nist.gov/mep)



# What MEP Does



- ✓ Work with small and medium size manufacturers to help them create and retain jobs, increase profits and save time and money
- ✓ Focus on meeting manufacturer's short term needs, but in context of overall company strategy.
- ✓ Reach over **30,000 manufacturing firms** and complete over **10,000 projects** per year.
- ✓ Provides companies with a consistent set of services



# Client Impacts

## MEP CLIENT IMPACTS

30,056  
Manufacturers  
served in FY2014



Each year, the MEP network has helped thousands of manufacturers increase profits, create jobs and establish a foundation for long-term business growth and productivity.

**\$6.7 Billion**  
New and Retained Sales

**63,954**  
Total Created and  
Retained Jobs

**\$2.7 Billion**  
New Client Investments

**\$1.1 Billion**  
Cost Savings

*Results reported by MEP clients receiving services in FY2014. Of the 8,353 clients selected to be surveyed, 6,088 completed the survey. Measures are a conservative snapshot of benefits. Recurring or cumulative benefits may be larger.*



# MEP Program Initiatives



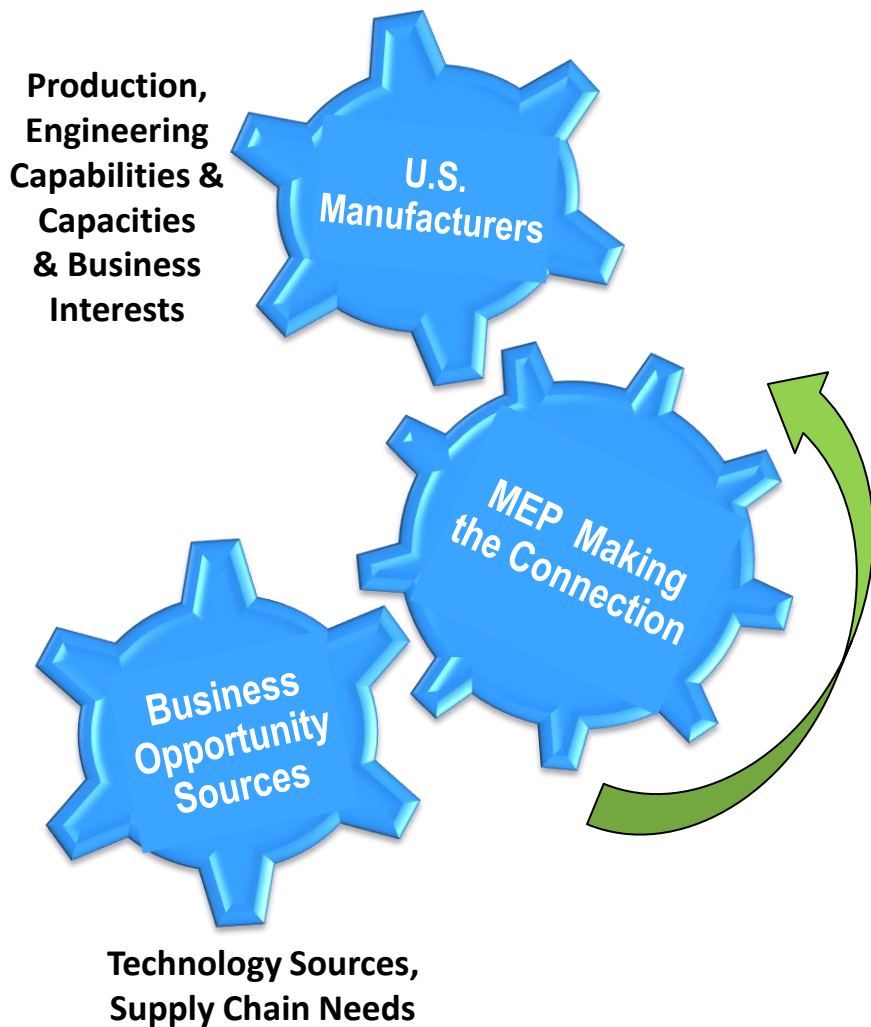
## MEP's Program Initiatives

are aimed to help manufacturers identify opportunities that will accelerate and strengthen their growth and competitiveness in the global marketplace





# MEP: Connecting and Assisting U.S. Manufacturers



- Enhance business opportunities for U.S. manufacturers
- *Connect* products, capabilities, capacities of U.S. (small) manufacturers with:
  - ✓ *Resources available from Nation's technology sources, including NIST Labs*
  - ✓ *New market opportunities*
  - ✓ *Supply chain needs of OEMs, Tier 1s, gov agencies*
- Provide *assistance* to manufacturers, including:
  - ✓ *Technical mfg services for products, processes*
    - *Manufacturing Strategy, Scale-up*
    - *Production Optimization, (Re)tooling (Lean/Quality/Automation)*
  - ✓ *Innovation and Product/Process Development*
  - ✓ *Supply Chain Reqts, Market Diversification*
  - ✓ *IP Management and Financing/Access to Capital*
  - ✓ *Workforce Development*
  - ✓ *Environmental Sustainability*
  - ✓ *Exporting*



# Small Manufacturers and Robotics

## *Next Steps*

- **Today's Workshop**
  - ✓ NIST MEP to post slides at [www.nist.gov/mep](http://www.nist.gov/mep)
  - ✓ Workshop Report to be produced and delivered to NIST Engineering Lab (EL)
- **MEP Assistance to Manufacturers**
  - ✓ Local MEP Centers available to work with manufacturers at the local level to provide assistance in response to needs – resulting from today's Workshop, other needs
    - All MEP Center contacts can be found via: [www.nist.gov/mep](http://www.nist.gov/mep)
  - ✓ NIST MEP available to coordinate national level MEP assistance resulting from today's Workshop, including relationships with NIST EL, or other...
- **NIST Lab Tours – Oct 8**



# Stay Connected

*Search* NISTMEP or NIST\_MEP



VISIT OUR BLOG!

<http://nistmep.blogs.govdelivery.com>

Get the latest NISTMEP news at:

[www.nist.gov/mep](http://www.nist.gov/mep)







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# TOUR OF NIST ENGINEERING LAB

100 Bureau Drive  
Gaithersburg, MD



## NIST VISITORS CENTER

- ✓ **ALL** visitors must stop at the NIST Visitors Center to get a temporary NIST badge.
- ✓ Photo identification and vehicle registration information must be presented at the main gate to be admitted to the NIST campus. Attendees must wear their NIST Visitors badge at all times while on the campus.
- ✓ Photo ID must be “REAL ID” Compliant.
- ✓ If your driver’s license was issued in **Arizona, Louisiana, or American Samoa**, you must present a passport or other Federal ID.
- ✓ If your driver’s license was issued in **Minnesota, New Hampshire, or New York**, NIST will accept only enhanced driver’s licenses (identified by the American Flag on the face of the card) or else you must present a passport or other Federal ID.

**Please arrive at the NIST Visitors Center no later than 8:50am, tour will begin promptly at 9:00am!!!**



# THANK YOU!!

